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DESIGN AND PERFORMANCE EVALUATION OF STEPPED THREADED PIN FIN AND COMPARISON WITH NON THREADED STEPPED PIN FIN

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ABSTRACT

In this project experimental investigation of stepped threaded pin fin heat transfer has been done using the materials brass. Out of these two, one is stepped threaded and other is stepped pin fin. The objective of this project is to determine the effectiveness and efficiency of stepped threaded pin fin and its comparison with fin like cylindrical experimentally. Also a detailed comparison of how much heat transfer takes places. On comparing it is found that the surface area of threaded pin fin is increased by 5.8 % from without threaded pin fin. Temperature drop in stepped threaded fin is more than stepped fin. From calculation experimental efficiency is more in case of stepped threaded compare to smooth fin

KEYWORDS: Band Heater, Fin Apparatus, Nusselt Number, Stepped Threaded Pin Fin & Threaded Pin Fin

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Original Article

INTRODUCTION

Enhancement of convective heat transfers by which of extended surface as well as established. The application of fins for better heat transfer are in many situation, the extended surface hence called fins, may be cylindrical pin fin further enhancement of heat transfer by pin fin can be obtained by developing threads on the fins as well as by using step fins in order to have minimization of materials as for analytical and experimental works for stepped pin fin uniform heat transfer tending towards the different classification of fin are available to increase the heat transfer from a surface, depend upon the fins conductivity of the materials. The fin is expressed to a following fluid which is cools or heat transfer it, with these (high) thermal conductivity allow to the increase heat transfer being conducted from the wall through the fin [1].

LITERATURE REVIEW

Dhumne Amul B., Hemant S.Farkade 2013[1]: Discussed experimental analysis of an heat transfer enhancement and cylindrical cross section area perforated pin fins in a rectangular channel, in this experimental and analysis of the cylindrical pin fin, fins in staggered sequence. Consider the experimental cover ranges and following type of in increasing heat transfer Reynolds number Nusselts number, when Reynolds number wise consider to the performance parameters, were developed for the heat transfer friction factor and enhanced efficiency.The experimental implementation show that the solid cylindrical pin fins leads to heat transfer increasing the cylindrical pin fins and increase the efficiency varies depend upon the material and there clearance ratio and enter fin.

Ganesh Murali J., Subrahmanya S Katte 2008 [2]: Described the analytically and numerically many works on pin fin has been show that presently radiating pin fin with treaded on its outside of the surface is investigate experiment, the rest of the facility with a vacuum chamber and instrumentation the heat input to the fin is varying such that the base temperature is maintain the constant underneath steady state. The steady show that there optimum angle of grooves and number of treaded per inch which is the heat losses per unit mass is a maximum, the treaded radiating fin losses 1.4 and 1.2 times greater heat per unit mass respectively to the comparison to base pin fin.

U S Gawai, et al. 2013 [3]: Described the experimental technique for the pin fin heat transfer have described the results. Heat transfer generally such as feature are known as dimple, and may be formed in a infinite variation heat transfer and friction characteristic heat transfer rate increasing using dimple based on the principle of the scrubbing cooling of action fluid taking place inside the dimple and phenomena of intensifying. Proposed of the works concerned with the experimental setup to the increasing the heat transfer rate of natural convection and forced convection heat transfer rate over the dimple surface.

Baskaya Senol, et al. 2000 [5]: Has made a research on done parametric study of natural convection heat transfer from the horizontal stepped threaded pin fin arrays. In which geometrical parameters investigated and the effect occur by fin spacing, length of fin, height of pin and the temperature difference between fins and surrounding, by the horizontal fin arrays the heat is transfer. With the help of only one or two parameter cannot possible to get maximum performance in terms of overall heat transfer. By considering all the design parameter the interactions is done. With the help of above study it shown that each of the variables produces an effect on the overall heat transfer is affected by the each variable parameter. From above analysis, it summarises that with increases in H, fin height and decreases in length L so the increases in overall heat transfer. By the previous investigation work and literature survey it shows that, it is installation of lengthwise short fins of single chimney pattern. In the vertical fin array the cooling is done by natural convection with sidewise entry of air. The air is heated when it reaches to the centre of fins, when coming from inwards, by decreasing in density as well as it rises. So, the fin is ineffective in the central portion because over from that part hot air-stream passes and therefore from that portion of fins does not carry large heat transfer.

Incropera, et al. 2007[6]: Discussed the research on Longitudinal fins of cylindrical profile are used to enhance heat transfer in applications ranging from heat sinks to space radiators. The lighter weight fins are triangular and trapezoidal profiles, but there is some disadvantages, in which higher production costs and safety issue due to its sharp tips. It is used where the light weight fins are required for continuous work.

Identification Gap

It has been found that air not adequate mater not adequate literature for threaded fin heat transfer, it has been thought under take experimental work on threaded fin heat transfer.

OBJECTIVE

In this project experimental investigation of stepped threaded pin fin heat transfer has been done using the materials brass and mild steel. Out of these two, one is stepped threaded and other is stepped pin fin of each materiel. The objective of this project is to determine the effectiveness and efficiency of stepped threaded pin fin and its comparison with fin like cylindrical experimentally. Also a detailed comparison of how much heat transfer takes place through both the materials.

METHODOLOGY

- For The optimum heat transfer i have prepared brass and mild steel material for threads fin.
- Stepped threaded pin fin and cylindrical fin axial along the length
- Experimental setup is to be preferred to take T, V and current reading.
- It has been studies in natural convection and forced convection, in natural convection have used grashof number for determine the convective heat transfer coefficient and nusselts number used.

ASSUMPTION:

The following Assumptions are considered analysis heat transfer.

- One dimensional steady Heat conduction.
- Isotropic material properties temperature independent.
- Absence of internal heat generation

Experimental Setup

Figure 1: Pin Fin Apparatus

Heat Transfer from Pin Fin Apparatus

- To calculate of Gr, Pr and Nu in natural convection
- Calculate the value of m and obtain the temperature at the each section along the length of the fin in natural convection and forced convection
- Calculate the heat transfer rate from the fin and the fin efficiency in natural and forced convection.

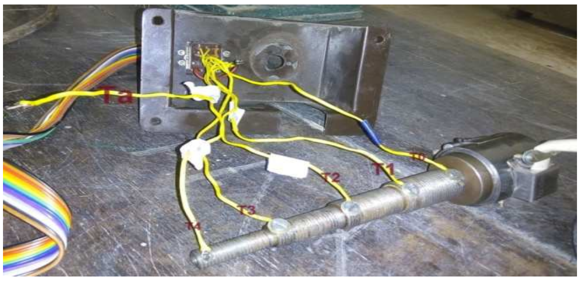
Assemble Part

The different parts have been assembling at the description are given below.

(a) Band Heater

(b) Rounded Iron

(d) Arrangement of Stepped Threaded Brass Pin Fin



(d) Arrangement of Stepped Unthreaded Brass Pin Fin

Figure 2

Block Diagram Showing the pin fin Dimensions is Given below

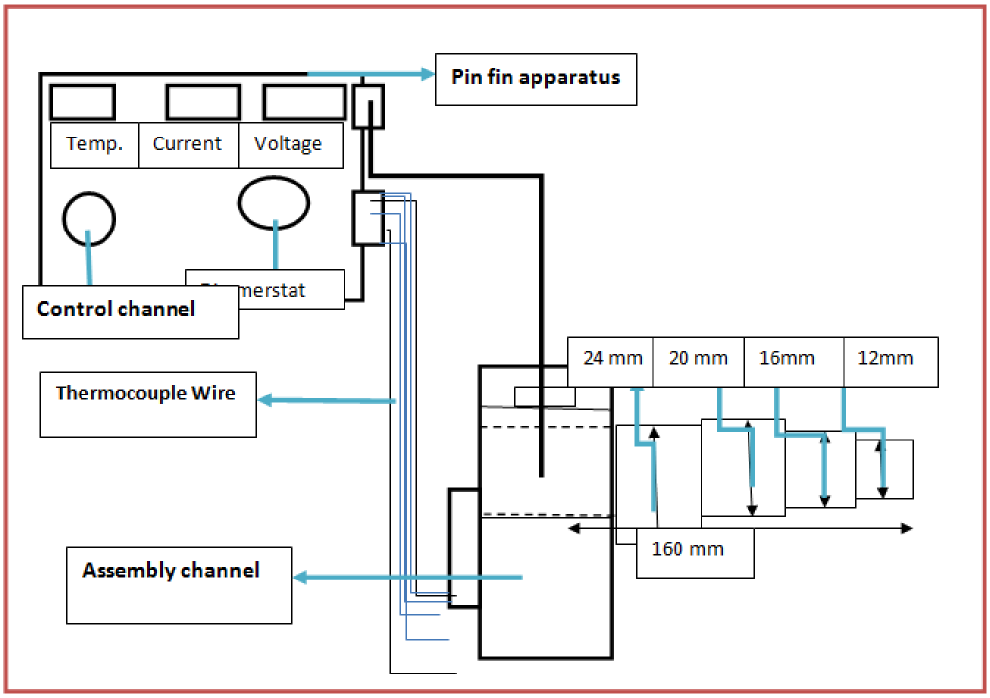


Figure3

CALCULATIONS

Each step length of the fin = 40 mm

Number of thermocouples = 5 thermocouple on the fin one to measures ambient temperature.

Thermal conductivity of air K_a = see from table 5

Conductivity of fin (Brass) K = 109 W/m-k

- **Consider for Stepped Threaded Fin for First Step**

Temperature indicator = (0-300) ^{0}C

Heater element = 250 watt type of band

Dimmerstat = vary to heater input

Voltmeter = digital (0-200) V

Ammeter current follow = digital (0-2) A

D_o = nominal diameter (major diameter), D = mean diameter, D_c = core diameter, P = pitch

For treaded surface area

Where treaded 1 inch per unit length is 14 threads.

1”=14 treaded, P= 1/number of thread per unit length, P= $\frac{1}{14}$=0.0714”, ∴ P = 1.81 mm

So mean diameter D = D_o-$\frac{p}{2}$= 24-$\frac{1.81}{2}$, D = 23.1 mm, And Core diameter D_c = D_o-depth = 24-1.81

D_c = 22.2 mm,D_o = 24 mm D = 23.1 mm

We consider for the pin fin mean diameter D = 23.1 mm

So surface area for threaded pin fin, A_s = number of threaded in flank surface of the fin × πd

= $2\pi \times 22 \times 23.1$, A_s = 3191 mm^2

- **Consider for Without Threaded**

Length of the fin L = 160 mm, Length of the each step L = 40 mm, Ad diameter of the fin step wise d_1 = 24 mm, d_2 = 20 mm, d_3 = 16 mm, d_4 = 12 mm, A_s = πdl, A_s= $\pi \times 24 \times 40$ = 3015 mm^2

On comparing it is found that the surface area of threaded pin fin is increased by 5.8 % from without threaded pin fin.

Table 1: Experimental Data of Stepped Threaded for Brass

S. No	Voltage (V)	Current (I)	Reading of Thermocouple (℃)					
			T_0	T_1	T_2	T_3	T_4	T_a
1	60	0.287	104.1	102.3	100.8	98.7	96.5	29.2
2	65	0.298	110.5	108.5	105.8	104.8	101.8	30
3	70	0.317	116.7	114.6	111.8	109.7	106.3	30.5
4	75	0.361	121.3	117.5	115.6	113.8	111.6	31
5	80	0.380	126.4	121.6	118.3	116.8	113.2	31.5

Heat Transfer Rate from Stepped Threaded Pin Fin

For Step threaded pin fin these are divided in to four sections, there are calculate one by one all parameter.

Cross sectional area A_c = $\frac{\pi d^2}{4}$, Parameter P = πd, Thermal conductivity of brass K = 209 W/m-k

For the first section T_0 at base temperature and for threaded T_d mean diameter at 23.1 mm.

$T_0 = 110.5\ ^0C$ $T_d = 108.5^0C$ Ambient temperature $T_a = 30\ ^0C$

Surface temperature $T_s = \frac{T_0+T_d}{2}$, $T_s = \frac{110.5+108.5}{2} = 109.5\ ^0C$, $T_a = 30\ ^0C$, $T_f = \frac{109.5+30}{2} = 69.75\ ^0C$

$(\Delta T) = T_s - T_f = 109.5\text{-}69.75 = 39.75\ ^0C$

$\beta = \frac{1}{(T_f+273)}\ K^{-1} = \frac{1}{(69.75+273)}, = 2.91\times10^{-3}$

The properties of the air at temperature 69.75 ^0C using by interpolation method from table [13]

$\nu = 20.01\times10^{-6}\ m^2/s$, $P_r = .694$, $K_a = .02965$ W/m-,$Gr = \frac{g\,\beta\,\Delta T\,d^3}{\nu 2} = \frac{9.81\times2.93\times10^{-3}\times39.75\times0.0231^3}{(20.01\times10^{-6})^2} = 3.4\times10^4$

Now $Gr\times Pr = 3.4\times10^4 \times0.694, = 2.4\times10^4$

As per reference [5] the formula for the valid range is

$Nu = 1.1(Gr.Pr)^{1/6}$ $\quad 10^{-1} < Gr\times Pr < 10^4$

$Nu = .53(Gr.Pr)^{1/4}$ $\quad 10^4 < Gr\times Pr < 10^9$

$Nu = .13(Gr.Pr)^{1/4}$ $\quad 10^9 < Gr\times Pr < 10^{12}$

(Gr×Pr) lies between 10^4 to 10^9 and using empirical relation of Nusselt Number.[5]

$Nu = .53(Gr.Pr)^{1/4}$ $\quad 10^4 < Gr.\ Pr < 10^9$

$Nu = .53\ (2.4\times10^4)^{0.24,}$ $Nu = 6.52$

Now we know that, $Nu = \frac{h\times d}{K_a}$, $6.52 = \frac{h\times0.0231}{0.02965}$, ∴ h = 8.33 W/m^2-k

Also we know that, $m = \sqrt{\frac{h\times p}{k\times Ax}}$ (where $p = \pi d$, $A_c = \frac{\pi d^2}{4}$), $m = \sqrt{\frac{4\times h}{k\times d}}$, $m = \sqrt{\frac{4\times8.33}{109\times0.0222}}$, ∴ m = 3.71 m^{-1}

Where value equating in equation (19) from appendix 2 heat transfer rate from insulated at the tip.

$Q_{fin} = \sqrt{hpkAc}\ (T_0 - T_a)\tanh\ (mL), = \sqrt{8.33\times0.0697\times109\times3.87\times10^{-4}}(110.5-30)\ \tanh\ mL$

$Q_{fin} = 6.69$ watt

Similarly heat transfer rate

For the second section T_0 at base temperature and T_d mean diameter at 19.1 mm.

$T_0 = 110.5\ ^0C$ $T_d = 105.8^0C$ ambient temperature $T_a = 30\ ^0C$

$T_s = \frac{T_0+T_d}{2}$, $T_s = \frac{110.5+105.8}{2}$, $=108.15\ ^0C$, $T_f = \frac{T_s+T_a}{2}$, $= \frac{9108.15+30}{2}$, $= 69\ ^0$, $\Delta T = T_s - T_f$, $= 39.7\ ^0C$

$Gr = \frac{g\,\beta\,\Delta T\,d^3}{\nu 2}$, $= \frac{9.81\times2.91\times10^{-3}\times39.75\times0.0191^3}{(20.01\times10^{-6})^2}$, $= 1.9\times\ 10^4$

$Gr\times Pr = 1.9\times\ 10^4\times0.694, = 1.3\times10^4$

We have, $Nu = 0.53\ (Gr.\ Pr)^{1/4}, = 0.53(1.3\times10^4)^{0.25}, = 5.66$

We know that, Nusselt number $Nu = \frac{h \times d}{K_a}$, $5.66 = \frac{h \times 0.0191}{.02952}$, h = 8.7 W/m^2, $m = \sqrt{\frac{h \times p}{k \times Ax}}$, $m = \sqrt{\frac{4 \times h}{k \times d}}$ $m = \sqrt{\frac{4 \times 8.74}{109 \times 0.0182}}$, m= 4.19 m^{-1}

Heat transfer rate from second step insulated at the tip.

$Q_{fin} = \sqrt{hpkAc}\,(T_0 - T_a)\tanh(mL)$, $= \sqrt{8.74 \times 0.057 \times 109 \times 2.60 \times 10^{-4}}\,(110.5 - 30)\tanh(4.19 \times 0.16)$

Q_{2fin} = 5.59 watt

For the third section T_0 at base temperature and T_d diameter at 15.1 mm.

T_0 = 110.5 ^{0}C ambient temperature T_a = 30 ^{0}C, and temperature T_d = 104.7 ^{0}C

Surface temperature $T_s = \frac{T_0 + T_d}{2}$, $= \frac{110.5 + 104.7}{2}$, = 107.7 ^{0}C

$T_f = \frac{T_s + T_a}{2} = \frac{107.7 + 30}{2}$ = 68.8 ^{0}C, $\Delta T = T_s - T_f$ =107.7 – 68.8 =39 ^{0}C

$Gr = \frac{g\,\beta\,\Delta T\,d^3}{\nu 2} = \frac{9.81 \times 2.93 \times 10^{-3} \times 39 \times 0.0151^3}{(20 \times 10^{-6})^2}$, $Gr = 9.6 \times 10^3$

Gr.Pr = $9.6 \times 10^3 \times 0.694$, = 6.6×10^3

As per reference [5] the formula for the valid range is

Hence Gr.Pr lies between 10^{-1} to 10^4

We have, $Nu = 1.1(Gr.Pr)^{1/6}$, $Nu = 1.1(6.6 \times 10^3)^{0.16,}$ Nu = 4.5

We know that, $Nu = \frac{h \times d}{K_a}$, $4.5 = \frac{h \times 0.0151}{.02952}$, h= 8.79 W/m^2-k

Also we know that, $m = \sqrt{\frac{h \times p}{k \times Ac}}$, $m = \sqrt{\frac{4 \times h}{k \times d}}$, $m = \sqrt{\frac{4 \times 8.79}{109 \times 0.0142}}$, m = 4.76 m^{-1}

Heat transfer rate from insulated at the tip.

$Q_{fin} = \sqrt{hpkAc}\,(T_0 - T_a)\tanh(mL) = \sqrt{8.97 \times 0.0446 \times 109 \times 1.58 \times 10^{-4}}\,(110.5 - 30)\tanh(4.76 \times 0.16)$

Q_{3fin} = 4.24 watt

For the fourth section T_0 at base temperature and T_d diameter at 15.1 mm.

T_0 = 110.5^{0}C T_d = 101.7 ^{0}C, Ta = 30 ^{0}C, $T_s = \frac{T_0 + T_d}{2} = \frac{110.5 + 101.7}{2}$ = 106 ^{0}C

$T_f = \frac{T_s + T_a}{2} = \frac{106 + 30}{2}$= 68 ^{0}C, $\Delta T = T_s - T_f$ =106 – 68 = 38 ^{0}C

$\beta = \frac{1}{(T_f + 273)}$ K^{-1} $= \frac{1}{(68 + 273)} = 2.93 \times 10^{-3}$

The properties of the air at temperature 68 ^{0}C using by interpolation method from table 13.

$\nu = 19.82 \times 10^{-6}\ m^2/s$, P_r =.6, K_a =.02952 W/m,

$Gr = \frac{g\,\beta\,\Delta T\,d^3}{\nu 2} = \frac{9.81 \times 2.93 \times 10^{-3} \times 38.14 \times 0.0111^3}{(19.82 \times 10^{-6})^2} = 3.8 \times 10^3$

$Gr.Pr = 3.8\times 10^3 \times 0.694 = 2.6\times 10^3$

As per reference [5] the formula for the valid range is

Gr.Pr lies between 10^{-1} to 10^4

We have, $Nu = 1.1(Gr.Pr)^{1/6}$, $= 1.1(2.6\times 10^3)^{0.16,} = 3.88$

Where $Nu = \frac{h\times d}{K_a}$, $4.5 = \frac{h\times 0.0111}{.02952}$, $h = 10.3\ W/m^2\text{-}k$

We know that $m = \sqrt{\frac{h\times p}{k\times Ac}}$, $m = \sqrt{\frac{4\times h}{k\times d}}$, $m = \sqrt{\frac{4\times 10.3}{109\times 0.0102}}$, $m = 6\ m^{-1}$

Heat transfer rate from insulated at the tip.

$Q_{fin} = \sqrt{hpkAc}\,(T_0 - T_a)\tanh(mL) = \sqrt{10.3\times 0.032\times 109\times 8.17\times 10^{-5}}(110.5-30)\tanh(6\times 0.16)$, Q_{4fin} = 3.24 watt

Heat transfer rate from by the Q_{fin} at each section of fin with add convective heat transfer rate calculate the total the total heat transfer rate by the fin.

Hence $Q_{total} = Q_1+Q_2+Q_3+Q$ = 6.69+5.59+4.24+3.2, = 19.77 watt

Efficiency of the fin (ɳ) = $\frac{\text{tamh}\ (mL)}{ml} = \frac{\text{tamh}\ (4.65\times 0.16)}{4.65\times 0.16}$, $ɳ_{fin}$ = 85 %

Table 2: Calculation data from experimental of Brass threaded pin fin

Nu) No.	Gr) No.	h(w/m^{2}K)	Q_{fin}(W)	(ɳ)
6.52	3.4×10^4	8.33	6.69	89.70
5.66	1.9×10^4	8.74	5.59	87.31
4.5	9.6×10^3	8.79	4.24	84.43
3.88	2.6×10^3	10.3	3.24	77.52

Table 3: Experimental data results of Brass threaded pin fin

Mean Film Temperature (T_f) (^{0}C)	Thermal Conductivity of Air(K_a) (W/mK)	Kinematic Viscosity(ϑ)$\times 10^{-6}$ (m^2/s)	Prandtl Number(Pr)
69.75	0.02965	20.1	0.694
69	0.02952	19.93	0.694
68.8	0.02931	19.89	0.694
68	0.02913	19.82	0.694

Table 4: Experimental Data of stepped for brass

S. No	Voltage (V)	Current (I)	Reading of Thermocouple (℃)					
			T_0	T_1	T_2	T_3	T_4	T_a
1	60	0.287	102.3	100.7	98.5	97.8	95.3	30.2
2	65	0.298	105.6	104.2	102.8	101.3	98.8	31.5
3	70	0.317	112.2	110.6	108.7	107.1	104.2	32
4	75	0.361	117.3	115.4	113.2	111.9	108.1	32.1
5	80	0.380	122.1	119.3	116.5	114.8	110.6	32.5

Heat Transfer Rate from Stepped Pin Fin for Brass Material

Diameter of the fin each section is given.

d_1 = 24 mm, d_2 = 20 mm, d_3 = 16 mm, d_4 = 12 mm

Thermal conductivity of mild steel K = 109 W/m-k

For the first step T_0 at the base temperature and T_d at 24 mm

Base temperature T_0= 105.6 ^{0}C ambient temperature T_a = 30 ^{0}C

And temperature T_d = 104.2 ^{0}, $T_s = \frac{T_0+T_d}{2}$, $T_s = \frac{105.6+104.2}{2}$ = 104.9 ^{0}C

$T_f = \frac{T_s+T_a}{2} = \frac{104.9+30}{2}$ = 67.45 ^{0}C, $\Delta T = T_s - T_f$ =104.9 –67.4 = 37.15 ^{0}C

$\beta = \frac{1}{(T_f+273)} K^{-1}$m $=\frac{1}{(67.45+273)}$, $(\beta) = 2.94\times10^{-3}$

The properties of the air at temperature 67.45 ^{0}C using by interpolation method from table 5.

Where $\nu = 19.6\times10^{-6}\ m^2/s$, P_r =.694, K_a =.02945 W/m-k

$Gr = \frac{g\,\beta\,\Delta T\, d^3}{\nu 2}$ (where d case of pin fin), $=\frac{9.81\times2.93\times10^{-3}\times37.15\times0.023^3}{(19.6\times10^{-6})^2}$, $=3.7\times10^4$

Now $Gr\times Pr = 3.7\times10^4 \times0.694 = 2.5\times10^4$

As per reference [5] the formula for the valid range is

$Nu = 1.1(Gr.Pr)^{1/6}$ $\quad 10^{-1} < Gr.Pr < 10^4$

$Nu = .53(Gr.Pr)^{1/4}$ $\quad 10^4 < Gr.Pr < 10^9$

$Nu = .13(Gr.Pr)^{1/4}$ $\quad 10^9 < Gr.Pr < 10^{12}$

$(Gr\times Pr)$ lies between 10^4 to 10^9 therefore using empirical relation of Nusselt number [5]

$Nu = .53(Gr.Pr)^{1/4}$ $\quad 10^4 < Gr.Pr < 10^9$

$Nu = .53\,(2.5\times10^4)^{0.25} = 6.72$

Now we know that, $Nu = \frac{h\times d}{K_a}$ (case of pin fin using d), $6.72 = \frac{h\times0.0231}{0.02923}$, ∴ h = 8.2 W/m^2-k

Also we know that, $m = \sqrt{\frac{h\times p}{k\times Ax}}$ (where $p=\pi d$, $A_c = \frac{\pi d^2}{4}$, $m = \sqrt{\frac{4\times h}{k\times d}}$, $m = \sqrt{\frac{4\times8.2}{109\times0.024}}$, ∴ m = 3.54 m^{-1}

Where value equating in equation (19) from appendix 2 heat transfer rate from insulated at the tip.

$Q_{fin} = \sqrt{hpkAc}\,(T_0 - T_a)\tanh(mL) = \sqrt{8.2\times0.06970.075\times109\times4.52\times10^{-4}}(96.6-30)\tanh mL$

Q_{fin} = 6.5 watt

Similarly we evaluate the value of all Gr, Pr,Nu h, m at each section of the fin and these heat transfer rate Q_{fin} with add convective heat transfer at each step calculate the total heat transfer from the fin.

Hence $Q_{total} = Q_1+Q_2+Q_3+Q_4\ Q_{fin}$ = 6.5+5.0+3.8+2.8 = 18.2 watt

Efficiency of the fin $(\eta) = \frac{\text{tamh}\,(mL)}{ml} = \frac{\text{tamh}\,(4.87\times0.16)}{4.87\times0.16}$ = 83.71 %

Table 5: Calculation Data from Experimental of Brass Without Threaded Pin Fin

Nu) No.	Gr) No.	(h)(w/m^{2}K)	Q_{fin}(W)	(η)
6.72	3.7×10^4	8.2	6.5	90
5.8	2.3×10^4	8.49	5	86.21
4.32	9.4×10^3	8.91	3.8	82.85
3.6	5.3×10^3	9.2	2.8	75.26

Table 6: Experimental Data Results of Brass without Threaded pin fin

Mean Film Temperature (T_f) (^{0}C)	Thermal Conductivity of Air(K_a) (W/mK)	Kinematic Viscosity(ϑ)$\times 10^{-6}$ (m^2/s)	Prandtl Number(Pr)
67.45	0.02945	19.6	0.694
66.75	0.02931	19.58	0.694
66	0.02925	19.51	0.695
65	0.02911	19.47	0.695

RESULTS AND DISCUSSIONS

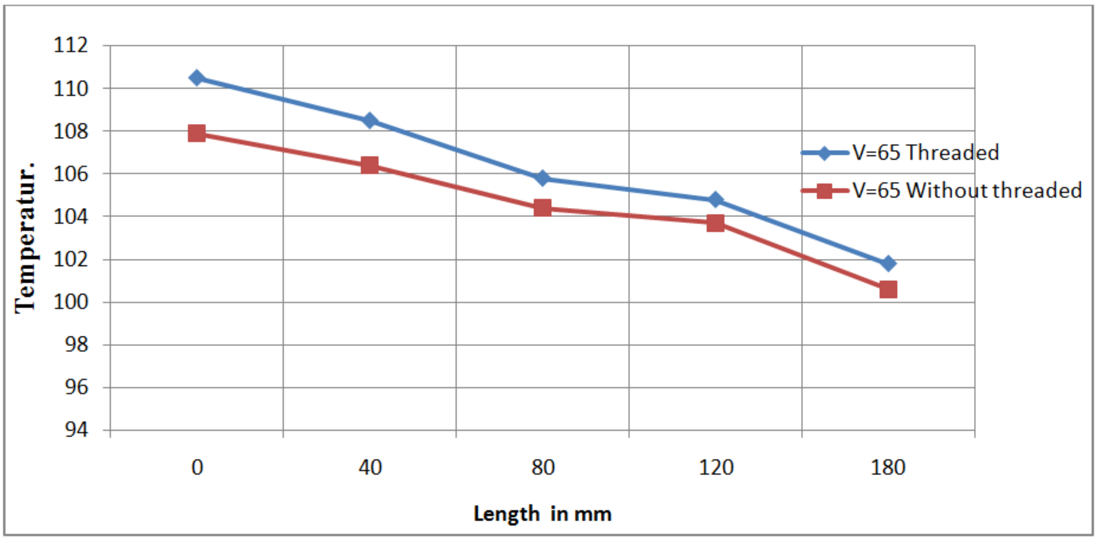


Figure 4: Graph between Temperature Versus Length

- Temperature drops across the length
- The temperature gap between stepped and stepped threaded increase the increasing towards at the tip of fin.
- Temperature drops has been stepped threaded fin(101.8 ^{0}C) more than stepped fin(100.6 ^{0}C).

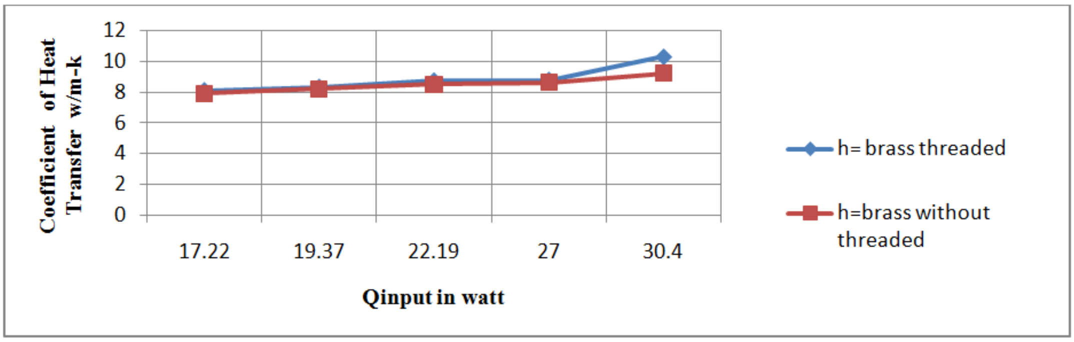


Figure 5: Graph Heat Transfer Coefficient Versus Qinput

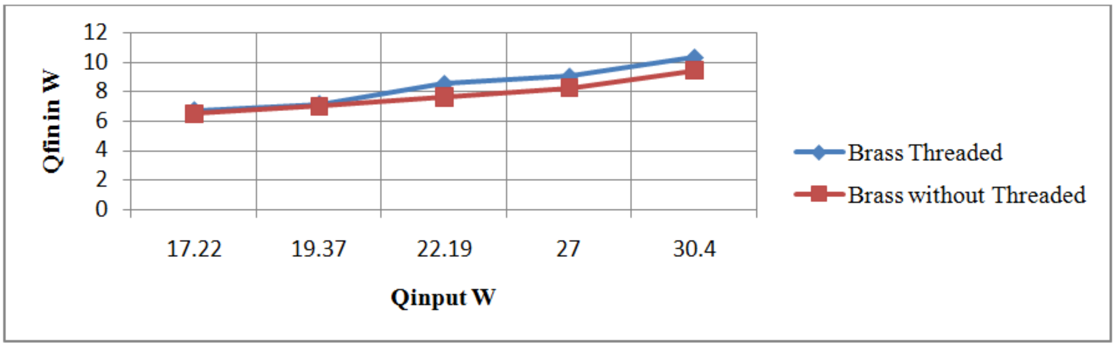


Figure 6: Graph Heat Input Versus Heat Transfer Rate

Shown above the Heat Input Versus Heat Transfer Rate

- The heat transfer increasing all materials to the fin with increasing the heat losses across the as above all graph of heat input versus heat transfer rate.

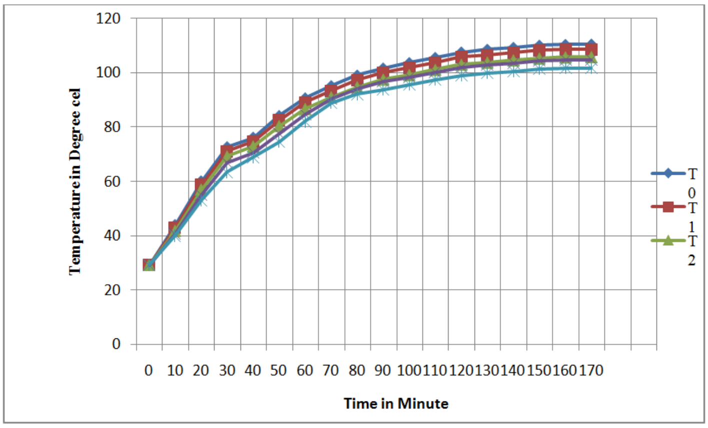


Figure 7: Graph between Temperature Versus Time

- Temperature increase with time then after some time steady state achieved.
- The steady state temperature and time are different for the different place as follows.
- For base the steady state temperature is (110.5,108.5,105.8,104.8,101.8 in ^{0}C) and time for the steady state is 165 minutes.

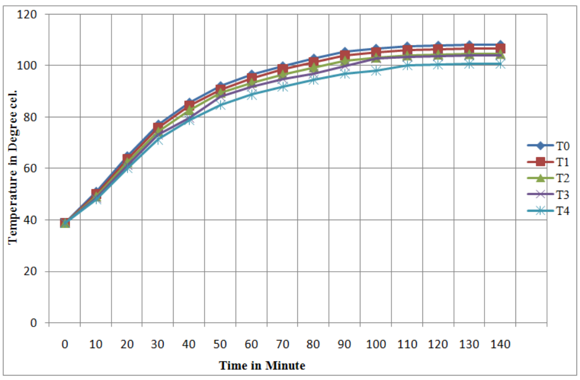


Figure 8: Graph between Temperature Versus Time

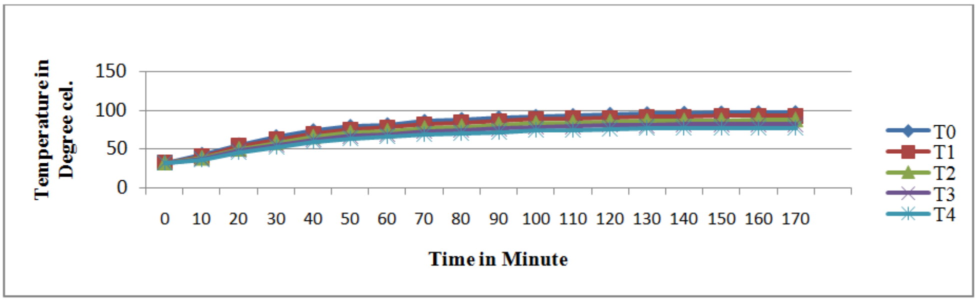


Figure 9: Graph between Temperature Versus Time

Shown Above the Figure Temperature Versus Time

- Temperature increase with time then after some time steady state achieved.
- The steady state temperature and time are different for the different place.
- For base the steady state temperature is above the all graph temperature versus time for the steady state at some minutes across the time.

CONCLUSIONS

The objective of this project work was to carry out a comparative experimental study and performance of stepped and stepped threaded fin have been done successfully and from this following conclusions have been made.

- Temperature drop in stepped threaded fin is more than stepped fin.
- efficiencyof stepped threaded fin is greather than stepped fin.
- Heat transfer Coefficient, Nusselt number of stepped threaded fin is more than stepped fin.
- In case of stepped threaded pin fin surface area increases by 5.8 %as compare to smooth stepped pin fin.
- From calculation experimental efficiency is more in case of stepped threaded compare to smooth fin.

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